

English version

Fibre-cement flat sheets - Product specification and test methods

Plaques planes en fibres-ciment - Spécifications du produit
et méthodes d'essai

Faserzement-Tafeln - Produktspezifikation und
Prüfverfahren

This draft European Standard is submitted to CEN members for unique acceptance procedure. It has been drawn up by the Technical Committee CEN/TC 128.

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Foreword

This document prEN 12467:2003 has been prepared by Technical Committee CEN/TC 128 “Roof covering products for discontinuous laying and products for wall cladding”, the secretariat of which is held by IBN.

This document is currently submitted to the Unique Acceptance Procedure.

This document will supersede EN 12467:2000.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

A distinction has been made between product appraisal (type tests) and factory production control requirements (acceptance tests).

Attention is drawn to the need for observance of EU and/or EFTA and national legal requirements restricting the use of certain materials e.g. asbestos and to the related marking and labelling requirements.

The performance of a building part constructed with these sheets depends not only on the properties of the product as required by this standard, but also on the design, construction and installation of the component as a whole in relation to the environment and conditions of use.

Annexes A and B are normative. Annexes ZA and ZB are informative.

This document includes a Bibliography.

1 Scope

This European Standard specifies the technical requirements and establishes methods of inspection and test as well as acceptance conditions for fibre-cement flat sheets, siding shingles and planks (referred to as sheets later in this standard) for one or more of the following uses:

- internal wall and ceiling finishes,
- external wall and ceiling finishes.

Products covered by this standard can be used for other purposes provided they comply with the relevant application standard, e.g. rigid underlays.

NOTE prEN (WI 128087) “Roof covering products for discontinuous laying and products for wall cladding - Rigid underlays - Rigid underlays for discontinuously laid roof coverings – Product specification and test methods” is under preparation.

This standard covers sheets reinforced with fibres of different types as specified in 5.1.1.

This standard does not cover sheets for fire protection purposes.

This standard does not include calculations with regard to works, design requirements, installation techniques, wind uplift or rain proofing of the installed sheets.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 197-1, *Cement – Part 1: Composition, specifications and conformity criteria for common cements*.

EN 13501-1, *Fire classification of construction products and building elements - Part 1: Classification using test data from reaction to fire test*.

EN ISO 12572, *Hygrothermal performance of building materials and products - Determination of water vapour transmission properties (ISO 12572:2001)*.

ISO 390, *Products in fibre-reinforced cement - Sampling and inspection*.

ISO 2602: *Statistical interpretation of test results - Estimation of the mean - Confidence interval*.

ISO 2859-1, *Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*.

ISO 3951, *Sampling procedures and charts for inspection by variables for percent non-conforming*.

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1

acceptance test

test to establish whether a batch of sheets conforms to a specification. The test is performed on samples drawn either from continuous production or from a consignment (ISO 390)

NOTE Test methods, specifications and limit values are specified in this standard. Sampling levels and acceptance criteria are specified in 6.3.2.

3.2

type test

test carried out to demonstrate conformity with the requirements of this standard or for the approval of a new product and/or when a fundamental change is made in formulation and/or method of manufacture, the effects of which cannot be predicted on the basis of previous experience. The test is performed on the as delivered product, but is not required for each production batch

3.3

acceptable quality level (AQL)

quality level which in a sampling plan corresponds to a specified, relatively high probability of acceptance. It is the maximum percent defective (or maximum number of defects per 100 units) that for purposes of sampling inspection can be considered satisfactory as a process average

NOTE A sampling scheme with an AQL of 4% means that batches containing up to 4% defective items have a high probability of acceptance.

3.4

apparent density

density based on the external dimensions of the sample to calculate the volume. This is an average density of material and pores

3.5

as-delivered

same condition as the producer intends to supply the product after completing all aspects of the process including maturing and, when appropriate, painting

3.6

upper face

face normally exposed

3.7

under face

reverse of upper face

3.8

textured sheets

sheets which have a relief pattern embossed or applied as a coating on their upper face before delivery

4 Symbols and abbreviations

a Nominal length or width of the sheet

b 1. Dimension of the specimen (length or width) measured parallel to the test machine supports, in millimetres

2. One of the coefficients of the regression line (see annex B)

d Apparent density of the sheet in grams per cubic centimetre

e Thickness of the sheet, in millimetres

F Breaking load, in newtons

l Length, in millimetres

l_s Span between the centres of the test machine supports in the bending strength test, in millimetres

m Mass of the specimen after drying, in grams

n Number of paired specimens

MOR Modulus of rupture, in megapascals

MOR_{fi} Modulus of rupture of the *i*th exposed specimen after the type test

MOR_{fci} Modulus of rupture of the *i*th unexposed reference specimen

MR_i Individual ratio of the modulus of rupture of the *i*th pair of exposed and unexposed specimens

R Average ratio of the modulus of rupture of exposed and unexposed specimens

R_L Lower estimate of the mean of the ratios at 95% confidence level of the modulus of rupture of exposed and unexposed specimens

s Standard deviation of the values in the appropriate calculation

μ Water vapour resistance value

V Volume of the specimen, in cubic centimetres

w Width, in millimetres

x_i Individual value of the i^{th} specimen tested dry

x_{Std} Minimum value to be used as the specification for the dry method of test. This value is calculated at the 97,5% lower confidence level from the value specified for the wet method of test in this standard (see B.5)

y_{Std} Minimum value specified in the standard for wet testing (see B.5)

x_0 Actual result obtained when dry testing (see B.4)

\bar{x} Mean of the values of x_i for $i = 1$ to n

y_i Individual value of the i^{th} specimen tested wet

y_0 Value calculated from the value obtained from a specimen tested dry, which is the estimate at the 97,5% lower confidence level of the value expected from a specimen tested wet (see B.4)

\bar{y} Mean of the values of y_i for $i = 1$ to n .

5 Requirements

5.1 General

5.1.1 Composition

Sheets shall consist essentially of cement or a calcium silicate formed by a chemical reaction of a siliceous and a calcareous material, reinforced by fibres. The cement shall comply with EN 197-1 or with technical specifications relevant in the country of use.

Two types of fibre-reinforced sheets are included in this standard:

- Type AT (Asbestos Technology) for sheets the formulation of which contains chrysotile asbestos,
- Type NT (Non-Asbestos Technology) for sheets the formulation of which does not contain asbestos.

The reinforcing fibres shall be one or more of the following forms:

- discrete elements randomly dispersed;
- continuous strands or tapes;
- nets or webs.

Process aids, fillers, aggregates and pigments may be added.

5.1.2 Appearance and finish

The exposed face of the sheets can be with or without texture. The sheets can be coloured or left in their natural colour. The sheets can also receive adherent coloured or uncoloured coatings on their surface. Variations of the surface appearance which do not impair the fitness for purpose of the sheets are permitted.

The sheets may be supplied with holes for fixing and/or cut to size.

5.2 Classification

5.2.1 General

Sheets covered by this standard are divided into:

- two types in accordance with their composition (see 5.1.1);
- four categories in accordance with their weather resistance (see 5.2.2 – 5.2.5);
- five classes in accordance with their bending strength (see 5.4.3);
- two groups of sizes in accordance with their method of installation (see 5.2.6);
- two levels in accordance with their dimensional tolerances (see 5.3.4).

Type tests for each category are specified in Table 7 (6.2.1).

5.2.2 Category A

Sheets which are intended for applications where they may be subjected to heat, high moisture and severe frost.

5.2.3 Category B

Sheets which are intended for applications where they may be subjected to heat, moisture and occasional frost, e.g. where they are either protected from or not subjected to severe weathering conditions.

5.2.4 Category C

Sheets which are intended for internal applications, where they may be subjected to heat and moisture, but not to frost.

5.2.5 Category D

Sheets for rigid underlayer applications.

5.2.6 Groups of sizes

5.2.6.1 Small size sheets

Sheets for which the method of installation includes horizontal overlap. Their dimensions are generally such that their area is $< 0,4 \text{ m}^2$ and have a length/width relation ≤ 3 .

5.2.6.2 Large size sheets

Sheets which do not correspond to indicators for small size sheets. Large sheets may be declared as "small size sheets" provided tolerances for small size sheets apply and are specified in the manufacturer's literature.

5.3 Dimensions and tolerances

5.3.1 General

There are two levels of tolerances for length, width, straightness and squareness of edges. Sheets shall comply with the requirements of the same level for the four sets of tolerances.

5.3.2 Nominal length and width

The manufacturer shall specify the nominal length and width of the sheets.

NOTE Sheets are normally available in nominal lengths up to 3 000 mm and nominal width up to 1 250 mm. Greater nominal lengths and widths can be supplied.

5.3.3 Thickness

The manufacturer shall specify the nominal thickness of the sheets.

For non textured sheets the nominal thickness refers to the average thickness. For textured sheets the nominal thickness refers to the maximum thickness.

NOTE 1 The nominal thickness of textured sheets cannot be used for the calculation of mechanical performance.

Sheets are normally available in thickness from 3 mm to 30 mm.

NOTE 2 Thicker sheets can be supplied.

5.3.4 Tolerances on nominal dimensions ¹

5.3.4.1 Tolerance on length and width

Tolerances on length and width shall be in accordance with Table 1, for the appropriate level.

Table 1 — Tolerance on nominal dimensions in accordance with value and level

Nominal dimension a^a	Level I	Level II
$a \leq 600$ mm	± 3 mm	± 4 mm
600 mm $< a \leq 1\ 000$ mm	± 3 mm	± 5 mm
1 000 mm $< a \leq 1\ 600$ mm	$\pm 0,3\% a$	$\pm 0,5\% a$
1 600 mm $< a$	± 5 mm	± 8 mm
a is the nominal width or length		

These tolerances are not applicable to oversize sheets.

The method of measurement is given in 7.2.3.1.

¹ For certain applications, tighter tolerances are required and should be agreed on between the manufacturer and the purchaser.

5.3.4.2 Tolerances on thickness

For non-textured sheets, tolerances shall be in accordance with Table 2.

Table 2 — Tolerance on thickness for non-textured sheets

$e \leq 6 \text{ mm}$	$\pm 0,6 \text{ mm}$
$6 \text{ mm} < e \leq 20 \text{ mm}$	$\pm 10 \% e$
$e > 20 \text{ mm}$	$\pm 2 \text{ mm}$

For sheets without texture, the maximum difference between extreme values of the thickness measurements within one sheet shall not exceed 10 % of the maximum measured value.

For textured sheets, tolerances shall be in accordance with Table 3.

Table 3 — Tolerance on thickness for textured sheets

$e \leq 6 \text{ mm}$	- 0,6 mm + 0,9 mm
$6 \text{ mm} < e \leq 20 \text{ mm}$	- 10% e + 15% e
$e > 20 \text{ mm}$	- 2 mm + 3 mm

For textured sheets the maximum difference between extreme values of the eight thickness measurements within one sheet shall not exceed 15 % of the maximum measured value.

The method of measurement is given in 7.2.3.2.

5.3.5 Tolerances on shape ²

5.3.5.1 Straightness of edges

Tolerances are applicable only to large size sheets.

The tolerance on the straightness of edges is defined as a percentage of the length of the edge of the relevant dimensions (length or width), and shall be in accordance with Table 4 for the appropriate level.

Table 4 — Tolerance on straightness of edges

Level I	Level II
0,1%	0,3%

The method of measurement is given in 7.2.3.3. These tolerances are not applicable for oversize sheets.

5.3.5.2 Squareness of edges

The tolerance on squareness of sheets shall be in accordance with Table 5, for the appropriate level.

² For certain applications, tighter tolerances are required and should be agreed on between the manufacturer and the purchaser.

Table 5 — Tolerance on squareness of edges

Level I	Level II
2 mm/m	4 mm/m

The method of measurement is given in 7.2.3.4.

These tolerances are not applicable for oversize sheets.

5.4 Physical requirements and characteristics

5.4.1 General

Mechanical and material properties are normally determined on sheets as delivered. The results shall be identified as applying to coated or uncoated material.

NOTE See annex B for statistic interpretation.

5.4.2 Apparent density

The manufacturer shall specify in his literature the minimum apparent density for each category of sheet. When tested in accordance with the method specified in 7.3.1 the density shall be not less than this value.

For type AT sheets, the apparent density shall be greater than 1,0 g/cm³.

5.4.3 Mechanical characteristics – Bending strength

When tested as specified in 7.3.2, the minimum modulus of rupture of the sheets, expressed in megapascals, shall be as specified in Table 6. The *MOR* shall be the average of the values obtained from testing the samples in both directions.

NOTE For non-homogeneous e.g. coated sheets, Table 6 refers to the apparent *MOR*.

Category A and B sheet strengths are specified in the wet condition.

Category C and D sheet strengths are specified in the ambient condition.

The minimum modulus of rupture of the sheets in the weaker direction shall be not less than 70 % of the specified value in Table 6 for the average of the two directions. This requirement does not apply to textured sheets.

Table 6 — Minimum modulus of rupture (MOR)

min. MOR in the wet condition MPa		min. MOR in the ambient condition MPa	
Classes	Category A & B	Classes	Category C & D
1	4	1	4
2	7	2	7
3	13	3	10
4	18	4	16
5	24	5	22

NOTE 1 Where manufacturers state minimum product MOR this should be at the 4% acceptable quality level (AQL).

NOTE 2 For textured sheets the MOR cannot be used for calculating mechanical performance.

5.4.4 Water impermeability for Categories A, B and D

When tested in accordance with 7.3.3, traces of moisture may appear on the under surface of the sheet, but in no instance shall there be any formation of drops of water.

5.4.5 Water vapour permeability for Category D

For flat sheets used as rigid underlays, the water vapour resistance value μ shall be determined according to 7.3.4 and shall be specified in the manufacturer's literature.

The μ value obtained from the test shall not be higher than the value specified by the manufacturer.

5.5 Durability requirements

5.5.1 General

Mechanical and material properties are normally determined for sheets as delivered. The results shall be identified as applying to coated or uncoated material. The performance of the coating in the following tests shall not be considered in the assessment of the product.

5.5.2 Freeze-thaw for Categories A, B and D

When tested in accordance with 7.4.1, after 100 freeze-thaw cycles for Category A and 25 cycles for Category B and D, the ratio R_L as defined in 7.4.1.4 shall be not less than 0,75.

5.5.3 Heat-rain

When tested in accordance with 7.4.2, after 50 heat-rain cycles for Category A and 25 cycles for Category B, any visible cracks, delamination, warping and bowing or other defects in the sheets shall not be of such a degree as to affect their performance in use.

- (a) Water tightness is tested according to 5.4.4.
- (b) Warping and bowing are visually assessed.

5.5.4 Warm water for Categories A, B, C and D

When tested in accordance with 7.3.5, after 56 days at 60 °C, the ratio R_L as defined in 7.3.5.4 shall be not less than 0,75.

5.5.5 Soak-dry for Categories A, B, C and D

When tested in accordance with 7.3.6, after 50 soak-dry cycles for Category A and 25 cycles for Categories B, C and D the ratio R_L as defined in 7.3.6.4 shall be not less than 0,75. Any visible cracks, delamination, warping and bowing or other defects in the sheets shall not be of such a degree as to affect their performance in use.

5.6 Fire and safety

5.6.1 Reaction to fire

When subject to regulatory requirements, the reaction to fire of the sheets shall be declared in accordance with 7.5.

5.6.2 Release of dangerous substances

5.6.2.1 Release of asbestos

Two types of fibre content exist: Type "AT" and type "NT" as defined in 5.1.1. The relevant type of sheet shall be declared in the information accompanying the marking (see 5.7).

For product type AT a declaration of the asbestos content shall be made by the manufacturer.

5.6.2.2 Release of other dangerous substances

For products containing substance(s) defined in Council Directive 76/769/EEC, the content shall be declared by the manufacturer. This applies to substances contained in the original formulation or created during the manufacturing process. In addition see annex ZA.

5.7 Product information

The manufacturer shall include the following in his literature:

- a) designation of the sheet:
 - type of product (see 5.1.1),
 - name of the sheet,
 - category,
 - class,
 - level of tolerances;
- b) nominal values for:
 - thickness,
 - length and width,

- c) minimum apparent density,
- d) instructions relevant to the handling and installation.

6 Evaluation of conformity

6.1 General

The conformity of products with the requirements of this standard shall be demonstrated by:

- initial type testing; and
- factory production control by the manufacturer.

6.2 Type testing

6.2.1 General

Type tests shall be carried out on sheets as delivered. If several formats, sizes and nominal thicknesses are being produced from the same composition and by the same production method, type tests only need to be carried out on the maximum and minimum thickness. If the ratio of the maximum to minimum thickness is greater than three then an additional intermediate thickness shall be tested.

All characteristics listed in Table 8 shall be subject to initial type testing, except reaction to fire Class A1 without testing and external fire performance “deemed to satisfy” products. The type tests relevant for each category are listed in Table 7.

Table 7 — Type tests relevant to each category of sheet

	Category			
	A	B	C	D
Impermeability	yes	yes	n.a. ^a	yes
Warm water	yes	yes	yes	yes
Soak-dry	50 cycles	25 cycles	25 cycles	25 cycles
Freeze-thaw	100 cycles	25 cycles	n.a. ^a	25 cycles
Heat-rain	50 cycles	25 cycles	n.a. ^a	n.a. ^a
Water vapour permeability	n.a. ^a	n.a. ^a	n.a. ^a	yes
External fire performance	yes or NPD ^b	yes or NPD ^b	yes or NPD ^b	yes or NPD ^b
Reaction to fire	yes or NPD ^b	yes or NPD ^b	yes or NPD ^b	yes or NPD ^b
Release of dangerous substances	yes or NPD ^b	yes or NPD ^b	yes or NPD ^b	yes or NPD ^b
^a not applicable ^b No performance determined				

Testing of mechanical characteristics is normally carried out with the upper face in compression. If required to establish a relationship between upper and under face testing, where significant differences are expected or if required for design purposes, the load shall be applied on the under face. Results obtained for under face testing are not relevant for classification.

6.2.2 Initial type testing

Initial type testing shall be performed to demonstrate conformity to this standard. Tests previously performed in accordance with the provisions of this standard (same product, same characteristic(s), test method, sampling procedure, same attestation of conformity, etc.) may be taken into account. In addition initial type testing shall be performed for the approval of a new product, a fundamental change in formulation or method of manufacture the effects of which cannot be predicted on the basis of previous experience.

The results of all type tests shall be recorded and held by the manufacturer for at least 5 years.

6.2.3 Further type testing

Whenever a change occurs in the fibre-cement sheet design, the raw material or supplier of components, or the production process, which would change significantly one or more of the characteristics, the type test shall be performed for the appropriate characteristic(s).

Table 8 — Number of samples and compliance criteria

Characteristic	Requirement	Assessment method	Number of samples	Compliance criteria
Mechanical resistance	5.4.3	7.2.2	Inspection S3 as per ISO 390	5.4.3 Table 6 apply 4% AQL
Density	5.4.2	7.3.1	Inspection by variable; method σ or s	5.4.2
Reaction to fire	5.6.1	7.5.2	7.5.2	7.5
Water impermeability	5.4.4	7.3.3	3 test sheets	5.4.4
Water vapour permeability	5.4.5	7.3.4	3 test sheets	5.4.5
Dimensional variations	5.3	7.2	Inspection S3 as per ISO 390	5.3.4 and 5.3.5
Release of dangerous substances	5.6.2	5.6.2		5.6.2
Warm water	5.5.4	7.3.5	10 samples	5.5.4 and 7.3.5.4
Soak-dry	5.5.5	7.3.6	10 samples	5.5.5 and 7.3.6.4
Freeze-thaw	5.5.2	7.4.1	10 samples	5.5.2 and 7.4.1.4
Heat rain	5.5.3	7.4.2	7.4.2.4	5.5.3 and 7.4.2.5

6.3 Factory production control (FPC)

6.3.1 General

The manufacturer shall establish, document and maintain a FPC system to ensure that the products placed on the market conform with the stated performance characteristics. The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the product.

A manufacturer who has established a Quality management system according to EN ISO 9001, is considered to satisfy the above requirements.

The results of inspections, tests or assessments requiring action shall be recorded, as shall the action(s) be taken.

6.3.2 Acceptance tests

The specifications of acceptance tests apply to the product as delivered, but may be carried out at an earlier stage of maturity.

Sampling from continuous production testing

- on the base sheet prior to coating,
- in conditions other than in Table 10,

is acceptable provided that it has been statistically established (see annex B) that compliance with the requirements given in Table 8 is ensured.

Acceptance tests can also be used to confirm that a batch of sheets conforms with the standard, e.g. in conjunction with type tests or for receiving inspection.

The tests include the:

- measurement of dimensions - length, width and thickness (method specified in 7.2.3);
- measurement of apparent density (method specified in 7.3.1);
- measurement of mechanical characteristics - bending strength (method specified in 7.3.2).

Each limit of specification, for the characteristics in Table 9, shall be subject to an AQL of 4 %. The sampling schemes provided in ISO 390, with an AQL of 4 % and an inspection level S_3 , ensure that for large batches approximately 95 % of the items fulfil the requirements.

Table 9 — Minimum sampling schemes

Length and width	ISO 2859-1
Thickness	Inspection by attribute
Straightness of edges	Double sampling
Squareness of edges	AQL 4%
	Level S_1
Apparent density	ISO 3951
Bending strength	Inspection by variable; method σ or s
	AQL 4%
	Level S_3

6.3.3 Equipment

All weighing, measuring and testing equipment shall be calibrated and regularly inspected according to documented procedures, frequencies and criteria.

6.3.4 Raw materials and components

The specification of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring conformity.

6.3.5 Product testing and evaluation

The manufacturer shall establish procedures to ensure that the stated values of all of the characteristics are maintained.

6.3.6 Non-conforming products

Non-conforming products shall be separated and handled according to documented procedures.

6.4 Inspection of a consignment of finished products

Inspection of a consignment of finished products is not a requirement of this standard but if, in special cases, it is demanded by the customer, it may be carried out in accordance with annex A and ISO 390.

7 Test methods

7.1 General

This part of the standard details both acceptance and type testing.

7.2 Dimensional and geometrical tests

7.2.1 Preparation of specimen

The test shall be performed on whole sheets as delivered and without conditioning.

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7.2.1.1 Small size sheets

Five randomly sampled sheets are tested.

7.2.1.2 Large size sheets

One sheet is tested.

7.2.2 Apparatus

7.2.2.1 Smooth, flat, rigid inspection surface of standard quality of dimensions appropriate to the dimensions of the sheets.

Two metal rules shall be fixed at right angles along adjacent edges of the inspection surface. The straightness of each metal rule shall be at least 0,3 mm/m and the right angle shall be accurate to at least 0,1 % (less than 1 mm deviation from normal per metre of length) or 0,001 rad.

Alternatively a portable square of at least 1 000 mm in each direction may be used. The same requirements for straightness and angularity apply.

7.2.2.2 Suitable short metal rulers capable of being read to 0,5 mm.

7.2.2.3 A suitable metal tape capable of measuring the length of the sheet to an accuracy of 1 mm.

7.2.2.4 A micrometer, reading at least to 0,1 mm, with flat parallel metal jaws between 10 mm and 15 mm in diameter.

7.2.3 Procedure

7.2.3.1 Measurement of length and width

7.2.3.1.1 General

Avoid taking the measurement over a local deformation which could be considered as a visual defect. Smooth any rough areas.

Take each reading to the nearest 1 mm.

7.2.3.1.2 Small size sheets

For each dimension carry out two measurements on each sheet i.e. one at about 50 mm from either end.

7.2.3.1.3 Large size sheets

For each dimension carry out three measurements i.e. one in the middle and one at about 50 mm from either end.

7.2.3.2 Measurement of thickness

7.2.3.2.1 Non-textured sheets

a) Carry out three measurements with a dial gauge, taking each reading to an accuracy of 0,1 mm.

Report the individual results. Calculate the arithmetic mean and difference between extreme values. Assess the results against the tolerances given in 5.3.4.2.

a1) Small size sheets

Carry out two measurements on each sheet, approximately 20 mm from the edge in the middle of two adjacent sides of the sheet.

a2) Large size sheets

Carry out three measurements across the width at one end of the sheet as indicated in Figure 1a.

Dimensions in millimetres

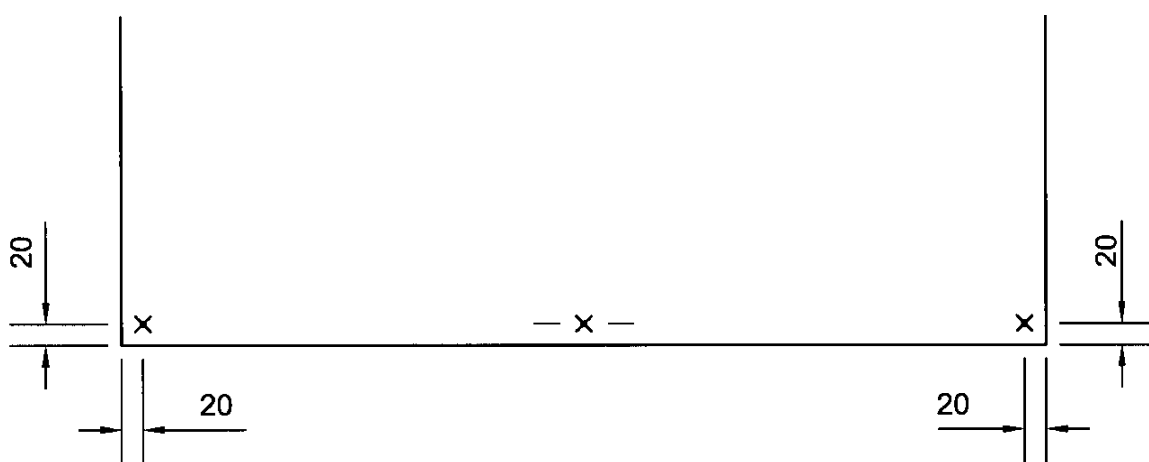


Figure 1a — Measurement of thickness of large size non textured sheets

7.2.3.2.2 Textured sheets

a) Carry out the measurements with a dial gauge, taking each reading to an accuracy of 0,1 mm.

Report the individual results. Calculate the arithmetic mean of the measurements and the difference between extreme values.

Assess the results against the tolerances given in 5.3.4.2.

The thickness obtained by this method shall not be used for calculation of *MOR* and density.

a1) Small size sheets

Measure the maximum thickness in the middle of all four sides of each sheet between 20 mm and 50 mm from the edge.

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a2) Large size sheets

Measure the maximum thickness of each test sheet at the eight positions as shown in Figure 1b between 20 mm and 50 mm from the edge.

b) For calculation of *MOR* and density:

b1) For embossed sheets and sheets with thin applied coating $\leq 0,5$ mm, determine the thickness of specimens from volume measurement by water displacement using the formula

$$e = \frac{1\,000 \times V}{l \times w}$$

where:

e is the specimen thickness in millimetres;

V is the volume of fluid displacement in cubic centimetres;

l is the length in millimetres;

w is the width in millimetres.

NOTE Alternative methods for determination of average thickness of textured product can be used, provided that they can be proven, on average, to yield a thickness measurement within ± 2 % of that determined from volume measurement by water displacement.

b2) For sheets with thick applied coating ($> 0,5$ mm), thickness is measured without the coating in accordance with 7.2.3.2.1.

Dimensions in millimetres

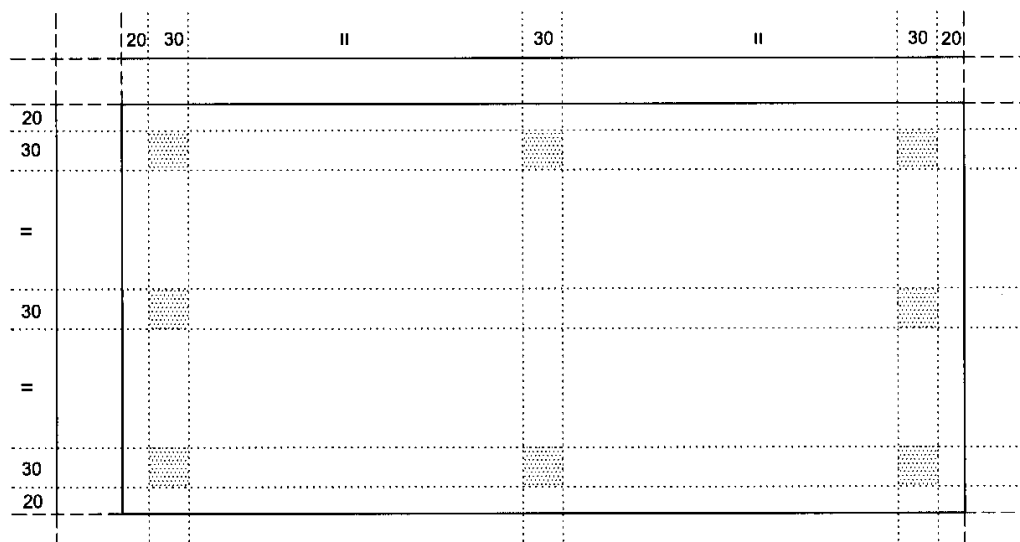


Figure 1b – Measurement of thickness of large textured sheets

7.2.3.3 Measurement of straightness of edges

For large size sheets measure on all four edges the greatest distance between the edge of the sheet and a string or wire stretched from one corner of the panel to the adjacent corner with a steel rule capable of reading to an accuracy of 0,5 mm.

7.2.3.4 Measurement of out squareness of sheet

Place two adjacent corners of the sheets in succession between the arms of the square keeping one side against the full length of the large arm and the other side in contact with the small arm at least at one point.

In this position measure to the nearest 0,5 mm the greatest distance of the sheet edge from the small arm of the square. Report each result.

7.2.4 Expression and interpretation of results

Length and width: Each value shall comply with the tolerance specified in 5.3.4.

Thickness: The average of the measurements shall be not less than the minimum specified by the manufacturer and shall comply with the tolerances specified in 5.3.4.2.

Straightness of edges: Each result shall be not more than the tolerance given in 5.3.5.1, appropriate for the intended level.

Squareness of edges: Each result shall be not more than the tolerance given in 5.3.5.2, appropriate for the intended level.

7.3 Tests for physical performance and characteristics

7.3.1 Apparent density

7.3.1.1 Preparation of specimen

The specimen shall preferably be a piece of a fibre-cement sheet used for the bending strength test.

7.3.1.2 Apparatus

7.3.1.2.1A ventilated oven capable of achieving a temperature of 100 °C to 105 °C with a full load of specimens.

7.3.1.2.2A balance accurate to within 0,1 % of the specimen mass and equipped to determine both the immersed mass and the non immersed mass of the specimen.

7.3.1.3 Procedure

Determine the volume V of the specimen by immersion in water or another method having an equivalent accuracy. In the case of immersion in water, the specimen shall be saturated in water beforehand.

Determine the mass m of the specimen after drying it in a ventilated oven maintained at 100 °C to 105 °C.

7.3.1.4 Expression and interpretation of results

The apparent density is given by the formula

$$d = \frac{m}{V}$$

where:

d is the apparent density in grams per cubic centimetres;

m is the mass of the specimen after drying in grams;

V is the volume of the specimen in cubic centimetres.

The result shall comply with the specification of 5.4.2.

7.3.2 Mechanical characteristics - Bending strength

7.3.2.1 Preparation of specimens

7.3.2.1.1 Shapes, dimensions of specimens and test span

The dimensions of specimens and test span shall be such that:

- a) the ratio span/nominal thickness is greater than or equal to 15;
- b) the ratio span/deflection at rupture is greater than or equal to 20;
- c) the length of specimens is greater than or equal to span plus 40 mm;

d) the width of specimens is greater than or equal to five times the nominal thickness of specimens.

Specimens may be either square or rectangular.

The preferred dimensions of specimens are 250 mm x 250 mm.

The preferred span is 200 mm.

Where the preferred dimensions and span do not meet conditions a) to d), the dimensions and span shall be adjusted to meet those conditions.

The dimensions of specimens and test span may be changed from the preferred values provided the conditions a) to d) are fulfilled.

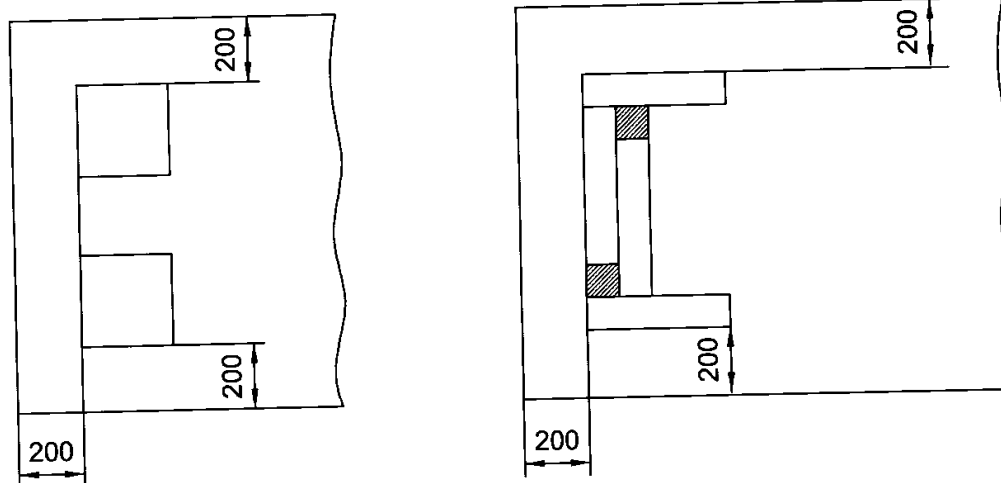
7.3.2.1.2 Cutting

7.3.2.1.2.1 Small size sheets

Five randomly sampled sheets are taken. For sheets smaller than 250 mm x 250 mm whole sheets are tested, for larger sheets one square test specimen of 250 mm x 250 mm is cut from each sheet.

7.3.2.1.2.2 Large size sheets

The test specimens are cut from the same part of the sheet. One possible layout is shown in Figure 2 (the distance of 200 mm is indicative). Other cutting layouts may be used provided that an equal number of specimens are cut perpendicular and parallel to the manufacturing direction.



Square specimens

Rectangular specimens

Figure 2 — Cutting of specimens from large size sheets

7.3.2.1.3 Conditioning

Specimens shall be conditioned in accordance with Table 10.

Table 10 – Conditioning

Test	Conditioning procedure
Acceptance test (wet) Categories A & B	24 h immersion in water for thickness \leq 20 mm 48 h immersion in water for thickness $>$ 20 mm between 7 and 14 days in ambient laboratory conditions
Acceptance test (ambient) Category C & D	Prior to the bending test: between 7 and 14 days in ambient laboratory conditions followed by 24 h immersion in water for sheets for thickness \leq 20 mm, or 48 h for thickness $>$ 20 mm
Type test Categories A, B & C	The specimens shall be tested immediately upon removal from the water.
Category D	Between 7 and 14 days in ambient laboratory conditions

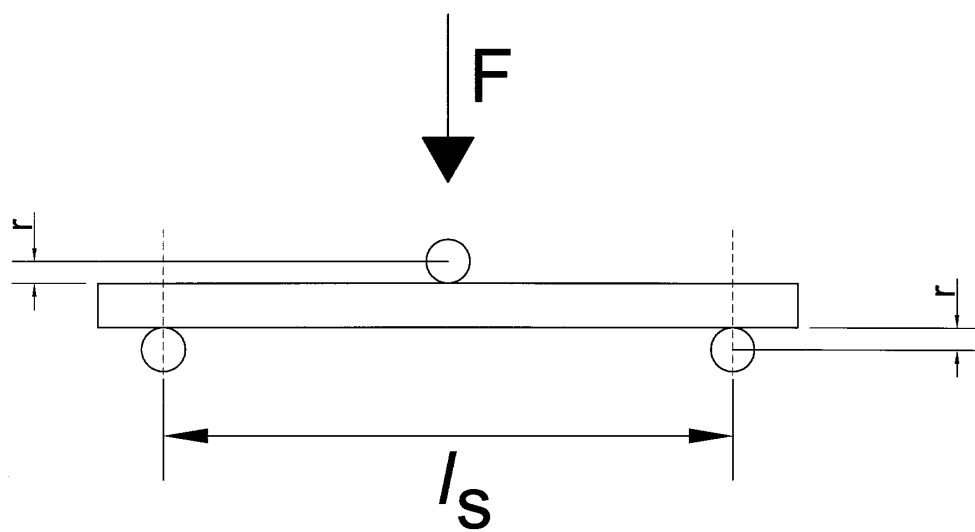
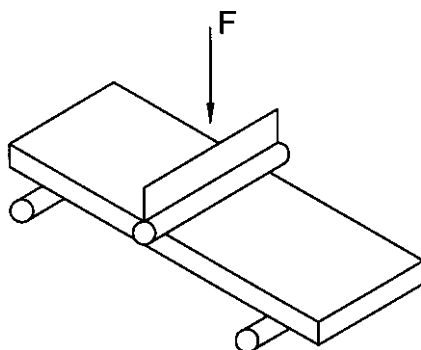
7.3.2.2 Apparatus

7.3.2.2.1 Bending test machine with a constant rate of deflection when applying the load (where this facility is not available a constant rate of loading is acceptable) and with an error of accuracy and an error of repeatability less than or equal to 3 % comprising:

- two parallel horizontal supports one fixed and the second free to move in order to align with the specimen. The upper face of each support shall be rounded with a radius between 3 mm and 25 mm. The distance l_s between the supports shall be in accordance with 7.3.2.1.1 (see Figure 3).
- A loading bar having the same radius as the supports and located parallel and equidistant from them. It shall be attached to the loading mechanism by means of a flexible joint.

The length of the supports and loading bar shall be at least equal to the width of the specimen.

7.3.2.2.2A micrometer reading to at least 0,1 mm with flat parallel metal jaws between 10 mm and 15 mm in diameter.



$r = 3 \text{ mm to } 25 \text{ mm}$

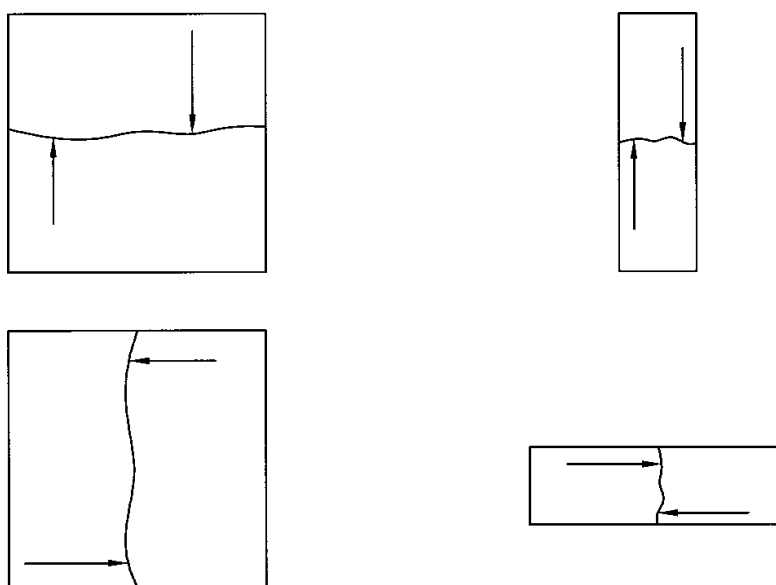
Figures 3a and 3b — Bending test machine

7.3.2.3 Procedure

Arrange the test piece with the underside against the supports and load the test piece by means of the central loading bar.

Load the specimen such that breakage occurs within 10 s and 30 s. A constant rate of deflection is preferred. Where this facility is not available a constant rate of loading is acceptable.

For non-textured specimens measure the thickness at two points, either before breaking along the loading line or after breaking along the broken edge as shown in Figure 4.



Square specimens

Rectangular specimens

Figure 4 — Measurement of thickness of specimens

For square specimens, re-assemble the broken pieces.

Submit the re-assembled specimens to a second bending test with the line of load application at right angles to that of the first test. Measure the thickness of the test piece at two points for smooth sheets along the new section of breakage as indicated in Figure 4.

Where rectangular specimens are used, the strengths in the two directions are obtained by testing each of the appropriate specimens (see Figure 4).

7.3.2.4 Expression and interpretation of results

The modulus of rupture *MOR*, in megapascals, for each breaking load direction is given by the formula:

$$MOR = \frac{3Fl_s}{2be^2}$$

where:

F is the breaking load, in newtons;

l_s is the span between the axes of supports, in millimetres;

b is the width of the test piece, in millimetres;

e is the average thickness:

— for non-textured sheets it is the arithmetic mean of two measurements for each breaking load direction,

— for face-textured sheets it is calculated from the volume measured by water displacement.

The modulus of rupture of the sheet(s) shall be the arithmetic mean of the five (ten) values (two values in each direction).

Assess the results against the specifications of 5.4.3.

7.3.3 Water impermeability

7.3.3.1 Preparation of specimens

Three specimens shall be cut, i.e. one from each of three sheets. For large size sheets, those used to provide specimens for other type-tests may be used or other sheets may be taken.

Specimen dimensions shall be according to the actual size for small size sheets. For large size sheets the dimension shall be 600 mm x 500 mm minimum except for narrow sheets when the dimensions shall be 600 mm x the maximum possible width.

7.3.3.2 Apparatus

A suitable frame shall be sealed on top of the specimen. The frame dimensions for small size sheets shall be 50 mm less than the length and width of the sheets. For large size sheets the frame dimension shall be 550 mm x 450 mm minimum. A narrow frame of the same length shall be used for narrow sheets.

7.3.3.3 Specimen conditioning

The specimens shall be kept in a controlled environment for at least 7 days at ambient temperature.

7.3.3.4 Procedure

Place and seal the frame on top of the face of the specimen and fill with water to a height of 20 mm above the face of the sheet. Place the specimens in a controlled environment at (23 ± 5) °C and (50 ± 10) % relative humidity so that the underside can be viewed without moving the specimen during the test. The duration of the test shall be 24 h.

7.3.3.5 Expression and interpretation of results

Examine the under face after 24 h and verify that it conforms to the specification of 5.4.4.

7.3.4 Water vapour permeability

The determination of the water vapour resistance value μ shall be carried out according to EN ISO 12572, Condition C. Compare the results with the specifications of 5.4.5.

7.3.5 Warm water

7.3.5.1 Preparation of specimens

Sample 10 sheets as delivered by the producer. Cut 10 sets of paired specimens to suit the bending strength test specified in 7.3.2.

Each specimen pair shall be cut adjacent in the machine direction in accordance with Figure 5 from one sheet and given the same number for later comparison of results.

Machine direction: \longleftrightarrow

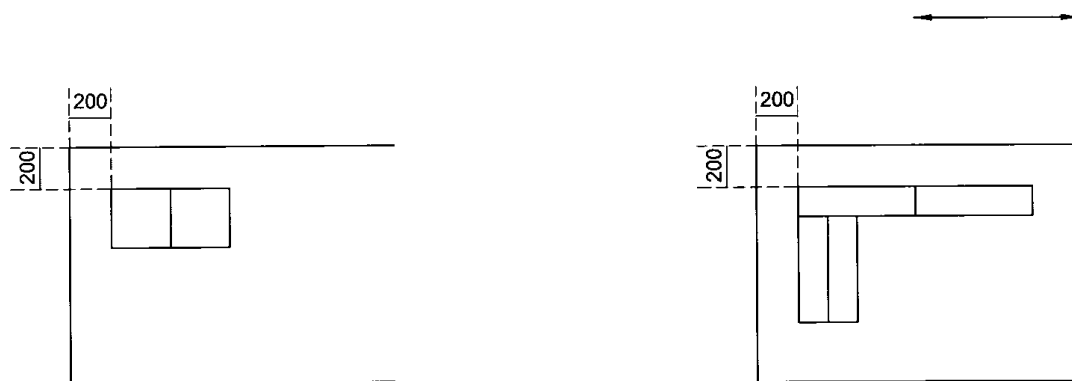


Figure 5 — Adjacent cutting

7.3.5.2 Apparatus

7.3.5.2.1 Water bath capable of temperature control to (60 ± 2) °C.

7.3.5.2.2 Testing equipment for determination of bending strengths as described in 7.3.2.2.

7.3.5.3 Procedure

Divide the paired specimens to form two sets of 10 specimens each.

Submit the first lot of 10 specimens to the bending strength test in accordance with 7.3.2.3 after conditioning in accordance with Table 10.

Immerse the 10 specimens of the second lot in water at (60 ± 2) °C saturated with product of the same composition, for (56 ± 2) days.

At the end of this period, condition the specimen in accordance with Table 10, then carry out the bending strength test in accordance with 7.3.2.

7.3.5.4 Expression and interpretation of results

For each pair of specimens i ($i = 1$ to 10), calculate the individual ratio, MR_i , as follows:

$$MR_i = \frac{MOR_{fi}}{MOR_{fci}}$$

where

MOR_{fi} is the modulus of rupture of the i^{th} specimen after the warm water test;

MOR_{fci} is the modulus of rupture of the i^{th} reference specimen (from the first lot).

Calculate the average, R , and standard deviation, s , of the individual ratio, MR_i .

Calculate the lower estimation, R_L , of the mean of the ratios at 95% confidence level (ISO 2602) as follows:

$$R_L = R - 0,58 \times s$$

Compare the results with the specifications of 5.5.4.

7.3.6 Soak-dry

7.3.6.1 Preparation of specimens

Sample ten sheets as delivered by the producer. Cut 10 sets of paired specimens to suit the bending test in 7.3.2.

Each specimen pair shall be cut adjacent in the machine direction in accordance with Figure 5 from one sheet and given the same number for later comparison of results.

7.3.6.2 Apparatus

7.3.6.2.1 Ventilated oven capable of achieving a temperature of (60 ± 5) °C and a relative humidity less or equal to 20% with a full load of specimens.

7.3.6.2.2 Bath filled with water at ambient temperature of more than 5 °C.

7.3.6.2.3 Testing equipment for determination of bending strength test as defined in 7.3.2.2.

7.3.6.3 Procedure

Divide the paired specimens to form two lots of 10 specimens each. After conditioning in accordance with Table 10 submit the first lot of 10 specimens to the bending test as described in 7.3.2.

At the same time submit the second lot to the relevant number of soak-dry cycles as specified in Table 7 consisting of:

— immersion in water at ambient temperature (more than 5 °C) for 18 h;

— drying in a ventilated oven of (60 ± 5) °C and relative humidity of less than 20% for 6 h. The 20% humidity shall be achieved for at least 3 h prior to the conclusion of the 6 hours drying.

If necessary, an interval up to 72 h between cycles is allowed. During this interval, specimens shall be stored in immersed conditions.

After the required number of cycles, place the specimens in a laboratory atmosphere for 7 days.

At the end of this period, condition the specimens in accordance with Table 10 and carry out the bending strength test as specified in 7.3.2.

7.3.6.4 Expression and interpretation of results

For each pair of specimens i ($i = 1$ to 10), calculate the individual ratio, MR_i , as follows:

$$MR_i = \frac{MOR_{fi}}{MOR_{fci}}$$

where

MOR_{fi} is the modulus of rupture of the i^{th} specimen after the soak-dry cycling;

MOR_{fci} is the modulus of rupture of the i^{th} reference specimen (from the first lot).

Calculate the average, R , and standard deviation, s , of the individual ratio, MR_i .

Calculate the lower estimation, R_L , of the mean of the ratios at 95 % confidence level (ISO 2602) as follows:

$$R_L = R - 0,58 \times s$$

Compare the result with the specification of 5.5.5.

7.4 Tests for climatic performance

7.4.1 Freeze-thaw

7.4.1.1 Preparation of specimens

Sample ten sheets as delivered by the producer. Cut 10 sets of paired specimens to suit the bending test (see 7.3.2).

Each specimen pair shall be cut adjacent in the machine direction in accordance with Figure 5 from one sheet and given the same number for later comparison of results.

7.4.1.2 Apparatus

7.4.1.2.1A freezer unit having forced air circulation, with air temperature control and capable of reaching the temperature specified in 7.4.1.3 within 1 h to 2 h with a full load of specimens.

7.4.1.2.2A water bath filled with water and maintained at (20 ± 4) °C.

7.4.1.2.3A bending test machine as described in 7.3.2.2.

7.4.1.3 Procedure

Divide the paired specimens to form two lots of 10 specimens each.

Submit the first lot of specimens to the bending strength test as described in 7.3.2 including the conditioning procedure (see Table 10).

At the same time immerse the second lot of specimens in water at ambient temperature ($> 5\text{ °C}$) for 48 h.

Then subject the second lot of specimens to the relevant number of freeze-thaw cycles as specified in Table 7:

- cool (freeze) in the freezer which shall reach a temperature of $(-20 \pm 4)\text{ °C}$ within 1 h to 2 h and hold at this temperature for a further 1 h,
- heat (thaw) in the water bath which shall reach a temperature of $(20 \pm 2)\text{ °C}$ within 1 h to 2 h and hold at this temperature for a further 1 h.

During both the cooling and heating (freezing and thawing) cycles position the specimens to enable free circulation of the conducting medium (air in the freezer or water in the bath) around them.

The temperature indicated refers to the temperature of the media, i.e. air or water.

Each freeze/thaw cycle shall take between 4 h and 6 h but an interval of 72 h maximum may be taken between cycles during which the specimens shall be stored in water at 20 °C .

Control of the freeze/thaw cycles can be automatic or manual. Continuous automatic cycling is preferable. For manual control record the completion of each cycle.

After the required number of cycles, carry out the bending strength test as specified in 7.3.2 including the conditioning procedure (see Table 10).

7.4.1.4 Expression and interpretation of results

For each pair of specimens, i ($i = 1$ to 10), calculate the individual ratio, MR_i , as follows:

$$MR_i = \frac{MOR_{fi}}{MOR_{fci}}$$

where:

MOR_{fi} is the modulus of rupture of the specimen from the i^{th} pair after freeze-thaw cycling (the second lot);

MOR_{fci} is the modulus of rupture of the specimen from the i^{th} pair tested for reference (the first lot).

Calculate the average, R , and standard deviation, s , of the individual ratio, MR_i .

Calculate the lower estimation, R_L , of the mean of the ratios at 95% confidence level (ISO 2602) as follows:

$$R_L = R - 0,58 \times s$$

Compare the result with the specification of 5.5.5.

7.4.2 Heat-rain

7.4.2.1 General

This test method provides a practical moisture movement test designed to determine the installed performance of flat sheets under cyclic changes in moisture content.

7.4.2.2 Preparation of specimens

Sheets used for the test shall be selected at random. The number of sheets required will depend upon the specified installation recommendations or on the size of sheets being tested (where appropriate, maximum size sheets), see 7.4.2.4.

7.4.2.3 Apparatus

7.4.2.3.1A framing system to which the sheets under test may be fixed in a vertical position, with the supporting members of a specified material and spacing.

7.4.2.3.2A water spray system with an output of approximately 1 l/m²/min which provides a complete wetting on the face.

7.4.2.3.3A heating device capable of maintaining the specified uniform temperature on the surface of the tested elements.

The heating device shall have a power output regulated by means of a black body temperature sensor located at the central area of the test rig where the maximum temperature is expected, i.e. at the closest distance underneath a heating unit.

The temperature at this location shall be regulated at (60 ± 5) °C and shall be reached after 15 min of heating.

At any time the difference between black body temperature in the centre and black body temperatures near the corners of the test rig (also measured underneath heating units) shall not exceed 15 °C.

7.4.2.3.4A control system allowing the test conditions to alternate as prescribed in the test procedure.

7.4.2.4 Procedure

One installation system, which is regarded as the most severe test for the sheets, shall be selected.

Assemble the test frame in accordance with the manufacturer's recommendations. The frame construction shall include at least one joint in its central region. The perimeter of the frame shall allow standard size sheet fixing.

The actual frame dimensions shall provide a minimum area of 3,5 m² and a maximum area of 12 m²:

— allow the specimens to be installed with vertical orientation; and

— allow the installation of at least two specimens as follows:

a) area per sheet greater than 1,8 m² - two sheets;

b) area per sheet not greater than 1,8 m² - sufficient sheets to cover an area of at least 3,5 m².

NOTE If the combined area of the specimens exceeds 12 m², the sheet length can be reduced to provide a test area of not more than 12 m².

Fix the specimens to the test frame in accordance with the manufacturer's recommendations and the following:

- edge fixing distance - minimum specified;
- spacing between fixings - maximum specified;
- include all waterproofing and other attachments normally specified;
- include joints in both directions.

Subject the assembled frame to the test cycle in accordance with Table 11:

Table 11 — Heat-rain cycle

Cycles	Duration
Water spray	2 h 50 min ± 5 min
Pause	10 min ± 1 min
Radiant heat	2 h 50 min ± 5 min
Pause	10 min ± 1 min
Total cycle	6 h ± 12 min
Repeat all steps	

7.4.2.5 Expression and interpretation of results

The result of the visual assessment shall conform to the specification of 5.5.3.

7.5 Test for reaction to fire performance

7.5.1 Sheets satisfying the requirements for the fire reaction Class A1 without the need for testing

Sheets containing 1 % or less organic substances by mass or volume, whichever is the more onerous, are considered to satisfy the requirements for performance Class A1 of the characteristics reaction to fire, in accordance with the provisions of EC Decision 96/603/EC, as amended, without the need for testing.

7.5.2 Other sheets

Sheets not covered by 7.5.1 shall be tested and classified in accordance with EN 13501-1. The sheets to be tested shall, where the test method requires, be installed, in addition to the general provisions given in the test method, in a manner representative of their intended use in accordance with the manufacturer's specifications.

8 Marking, labelling and packaging

The packaging of sheets shall be marked with at least the following:

- a) manufacturer's identification;
- b) number of this standard;
- c) size and/or name;

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- d) category;
- e) class;
- f) level of tolerance;
- g) date of manufacture;
- h) “**AT**” for sheets of type AT; “**NT**” for sheets of type NT.

A minimum of 50 % of sheets greater than 2,5 m² in each delivered unit shall be durably marked with at least items a), d), e), g) and h) from the above list. For smaller sizes there shall be on average one marking every 5 m².

For sheets intended for decorative purposes, the marking of the sheets may be reduced by agreement between manufacturer and purchaser.

Where ZA.3 covers the same requirements as this clause, the requirements of this clause are met.

Annex A (normative)

Consignment inspection sampling

A.1 When tenders or orders specify it, the acceptance sampling shall be carried out in lot(s) of the consignment in accordance with the test programme of this product standard, unless there is a special agreement. Therefore, the test programme necessarily covers the characteristics as specified in Table 8.

Details related to the application of the sampling clause shall be established in agreement between the manufacturer and the purchaser.

A.2 After agreement on the sampling procedure, sampling shall be carried out, in the presence of both parties, from lot(s) which are to be delivered to the purchaser. If the inspection lot(s) are not yet formed, the manufacturer should present to the purchaser the stock(s) from which the inspection lot(s) can be selected and marked. Unless otherwise agreed between the manufacturer and purchaser, the maximum and minimum inspection lots shall be 8 000 and 4 000 fibre-cement flat sheets.

A.3 The tests shall be carried out by the laboratory of the manufacturer or by an independent laboratory selected by mutual agreement between the manufacturer and the purchaser. In case of dispute, the tests shall be carried out in the presence of both parties.

A.4 When non-destructive tests are carried out and the result of the sampling inspection does not meet the acceptance tests requirements of this standard, the tests shall be required on each item of the consignment. The units of the consignment which do not meet the requirements when tested one by one can be refused and disposed of, unless otherwise agreed between the manufacturer and purchaser.

Annex B (normative)

Statistical method for determining the corresponding wet values or revised dry specifications for the MOR when carrying out the dry method of test or when tested prior to coating for quality control purposes

B.1 Procedure

Sample at least 20 sheets. Cut them into paired specimens for the bending strength test described in 7.3.2.

Both specimens of a pair shall be cut from the same sheet and each given the same number.

Test one set of specimens wet and one set of specimens dry for bending strength in accordance with 7.3.2.

From the paired results determine whether there is a correlation between them at the 97,5 % confidence level using the method in B.2.

If there is no significant correlation then dry testing cannot be used. If the correlation is positive then continue as follows:

- a) determine the regression line using the method described in B.3;
- b) determine either of the following:
 - a wet value for each specimen from the obtained dry value, using the method described in B.4;
 - a revised minimum value to be used as the specification for dry testing corresponding to the appropriate minimum value for wet testing as specified in this standard using the method described in B.5.

B.2 Determination of the correlation between the results of testing wet and dry specimens

Calculate the coefficient of correlation between wet and dry values from the following equation:

$$r = \frac{\sum_1^n (x_i - \bar{x})(y_i - \bar{y})}{\left\{ \sum_1^n (x_i - \bar{x})^2 \sum_1^n (y_i - \bar{y})^2 \right\}^{1/2}} \quad (\text{B.1})$$

where

n is the number of paired specimens;

x_i is the individual value of the i^{th} specimen tested dry;

y_i is the individual value of the i^{th} specimen tested wet;

\bar{x} is the mean of the values of x_i for $i = 1$ to n ;

\bar{y} is the mean of the values of y_i for $i = 1$ to n .

Calculate the value of t from the following equation:

$$t = \left| \frac{r}{\sqrt{1-r^2}} \right| \sqrt{n-2} \quad (\text{B.2})$$

Compare t to the Student's coefficient $t_{0,025/n-2}$.

If $t > t_{0,025/n-2}$ then there is a significant relationship between the results of wet and dry testing and the regression line is straight. Dry testing can be carried out for quality control purposes

— when $n = 20$ then $t_{0,025/n-2} = 2,101$;

— for $n > 20$ refer to Student's t tables.

B.3 Determination of the regression line

The equation of the regression line is

$$y = a + bx$$

Calculate the values of a and b from the following equations:

$$b = \frac{\sum_1^n (x_i - \bar{x})(y_i - \bar{y})}{\sum_1^n (x_i - \bar{x})^2} \quad (\text{B.3})$$

$$a = \bar{y} - b\bar{x} \quad (\text{B.4})$$

A plot of the regression line is shown in Figure B.1.

B.4 Determination of a value for wet testing from an obtained value for dry testing

Calculate the residual standard deviation (also called the standard error of the estimate) from the following equation

$$s = \sqrt{\frac{\sum_1^n (y_i - a - bx_i)^2}{n-2}} \quad (\text{B.5})$$

Calculate the value for wet testing from the following equation using the obtained dry value x_0 :

$$y_0 = (a + bx_0) - s t_{0,025/n-2} \sqrt{\frac{n+1}{n} + \frac{(x_0 - \bar{x})^2}{\sum_1^n (x_i - \bar{x})^2}} \quad (\text{B.6})$$

where:

x_0 is the actual result obtained when dry testing;

y_0 is the value calculated from x_0 which is the estimate at the lower 97,5% confidence level of the value expected from wet testing:

— when $n = 20$ then $t_{0,025/n-2} = 2,101$;

— for $n > 20$ refer to Student's t tables.

For routine quality control testing individual values of y_0 can be calculated each time or alternatively by substituting a suitable range of values for x_0 in equation B.6 a plot of x_0, y_0 can be made (see Figure B.1) from which future values can be read.

B.5 Determination of the minimum value specified for dry testing x_{std} corresponding to the minimum value specified for wet testing in this standard y_{std}

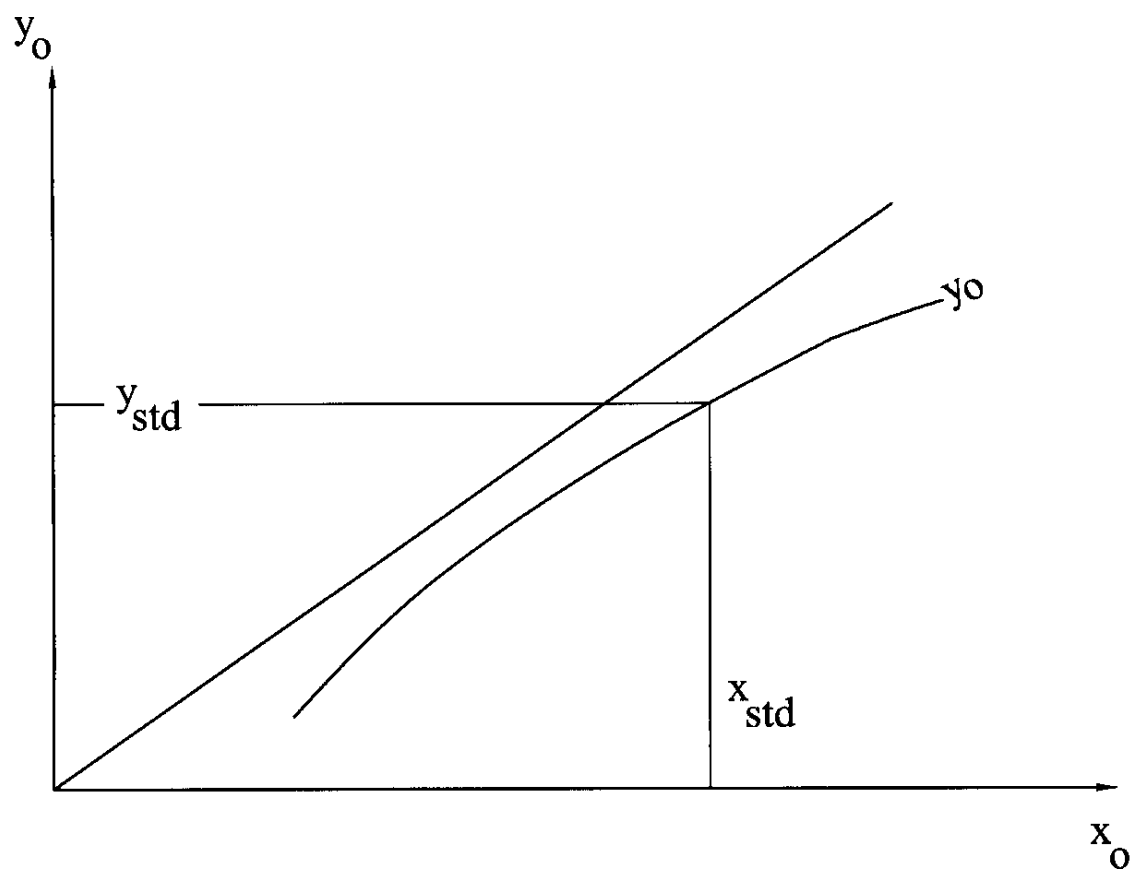
Plot the line for y_0, x_0 by substituting a suitable range of values for x_0 in equation B.6.

Read the value for x_{std} corresponding to the value for y_{std} from the graph (see Figure B.1)

where:

y_{std} is the minimum value specified in the standard for wet testing;

x_{std} is the minimum value to be specified for dry testing calculated from y_{std} at the 97,5% lower confidence level.

**Key**

- A Wet values
- B Regression line
- C (from equation B.6)
- D Dry values

Figure B.1 – Regression line for wet / dry values with lower confidence level

Annex ZA (informative)

Clauses of this European Standard addressing the provisions of the EU Construction Products Directive

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under Mandate M/121 “Internal and external wall and ceiling finishes” given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European Standard shown in this annex meet the requirements of the mandates given under the EU Construction Products Directive (89/106).

Compliance with these clauses confers a presumption of fitness of the construction products covered by this European Standard for their intended use.

WARNING — Other requirements and other EU Directives, not affecting the fitness for intended use may be applicable to a construction product falling within the scope of this standard.

NOTE In addition to any specific clauses relating to dangerous substances contained in this standard, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply. An informative database of European and national provisions on dangerous substances is available at the Construction web site on EUROPA (CREATE, accessed through <http://europa.eu.int/comm/enterprise/construction/internal/dangsub/dangmain.htm>).

This annex has the same scope as clause 1 of this standard. It establishes the conditions for the CE marking of the fibre cement flat sheets intended for the uses indicated in Tables ZA.1.1 to ZA.1.2 and shows the relevant clauses applicable.

Construction product: Fibre cement flat sheet

Intended use (1): Internal wall and ceiling finishes

Table ZA.1.1 — Relevant clauses for internal wall and ceiling finishes

Essential characteristics	Clauses in this European Standard	Mandated levels and/or classes	Notes
Mechanical resistance	5.4.3	-	Technical Classes 1 to 5 Does not apply to wall finishes
Reaction to fire	5.6.1	A1 to F	
Release of dangerous substance	5.6.2	-	
Durability against warm water	5.5.4	-	Technical Classes 1 to 5
Durability against soak / dry	5.5.5	-	Technical Classes 1 to 5

Construction product: Fibre cement flat sheets

Intended use (2): External wall and ceiling finishes

Table ZA.1.2 — Relevant clauses for and external wall and ceiling finishes

Essential characteristics	Clauses in this European Standard	Mandated levels and/or classes	Notes
Mechanical resistance	5.4.3	-	Technical Classes 1 to 5 Does not apply to wall finishes
Reaction to fire	5.6.1	A1 to F	
Release of dangerous substance	5.6.2	-	
Water permeability	5.4.4		For Categories A and B
Durability against warm water	5.5.4	-	Technical Classes 1 to 5
Durability against soak / dry	5.5.5	-	Technical Classes 1 to 5
Durability against freeze-thaw	5.5.2	-	Technical Classes 1 to 5
Durability against heat-rain	5.5.3	-	Technical Classes 1 to 5

NOTE For rigid underlayers for discontinuously laid roof coverings for building, see prEN (WI 128087).

The requirement on a certain characteristic is not applicable in those Member States (MSs) where there are no regulatory requirements on that characteristic for the intended use of the product. In this case, manufacturers placing their products on the market of these MSs are not obliged to determine nor declare the performance of their products with regard to this characteristic and the option “No performance determined” (NPD) in the information accompanying the CE marking (see ZA.3) may be used. The NPD option may not be used, however, where the characteristic is subject to a threshold level.

ZA.2 Procedure for the attestation of conformity of fibre cement slates and fittings

ZA.2.1 Systems of attestation of conformity

The systems of attestation of conformity for fibre cement flat sheets indicated in Tables ZA.1.1 and ZA.1.2, as given in Annex III of the Mandate M/121, are shown in Table ZA.2 for the intended uses and relevant level(s) and classes.

Table ZA.2 — Attestation of conformity systems

Product	Intended use	Level(s) or class(es)	Attestation of conformity system
Fibre cement flat sheets	All uses subject to reaction to fire regulations	A1**, A2**, B**, C**, D and E	3
		A1*** and F	4
	For uses subject to regulations on dangerous substances	-	3
<p>** Products/materials for which there is no clearly identifiable stage in the production process which results in an improvement of the reaction to fire classification (e.g. an addition of fire retardants or a limiting of organic material)</p> <p>*** Products/materials that do not require to be tested for reaction to fire (e.g. products/materials of Class A1 according to Commission Decision 96/603/EC, as amended)</p>			
<p>System 3: See Directive 89/106/EEC (CPD) Annex III.2.(ii), Second possibility System 4: See Directive 89/106/EEC (CPD) Annex III.2.(ii), Third possibility</p>			

The attestation of conformity of the fibre cement flat sheets and fitting in Tables ZA.1.1 and ZA.1.2 shall be according to the evaluation of conformity procedures indicated in Table ZA.3.1 and ZA.3.2 resulting from the application of the clauses of this European Standard indicated therein.

Table ZA.3.1 – Assignment of evaluation of conformity tasks for system 3

Tasks	Content of the task	Evaluation of conformity clauses to apply
Tasks for the manufacturer	Factory production control (F.P.C)	Parameters related to all characteristics of Tables ZA.1.1 and/or ZA.1.2 relevant for the intended use
	Initial type testing by the manufacturer	All characteristics of Tables ZA.1.1 and/or ZA.1.2 relevant for the intended use, i.e. mechanical resistance, water permeability and durability, other than those shown below
	Initial type testing by the notified lab	Reaction to fire (Classes A1**, A2**, B**, C**, D, E) and dangerous substances

Table ZA.3.2 – Assignment of evaluation of conformity tasks for system 4

Tasks		Content of the task	Evaluation of conformity clauses to apply
Tasks for the manufacturer	Factory production control (F.P.C)	Parameters related to all characteristics of Tables ZA.1.1 and/or ZA.1.2 relevant for the intended use	6.3
	Initial type testing	All characteristics of Tables ZA.1.1 and/or ZA.1.2 relevant for the intended use, i.e. mechanical resistance, water permeability and durability	6.2

ZA.2.2 EC Declaration of conformity

(In case of products under system 3): When compliance with the conditions of this annex is achieved, the manufacturer or his agent established in the EEA shall prepare and retain a declaration of conformity (EC Declaration of conformity), which entitles the manufacturer to affix the CE marking. This declaration shall include:

- name and address of the manufacturer, or his authorised representative established in the EEA, and place of production;
- description of the product (type, identification, use, ...) and a copy of the information accompanying the CE marking;
- provisions to which the product conforms (i.e. annex ZA of this EN);
- particular conditions applicable to the use of the product (e.g. provisions for use under certain conditions);
- name and address of the notified laboratory(ies);
- name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or his authorised representative.

(In case of products under system 4): When compliance with this annex is achieved, the manufacturer or his agent established in the EEA shall prepare and retain a declaration of conformity (EC Declaration of conformity), which entitles the manufacturer to affix the CE marking. This declaration shall include:

- name and address of the manufacturer, or his authorised representative established in the EEA, and place of production;
- description of the product (type, identification, use, ...) and a copy of the information accompanying the CE marking;
- provisions to which the product conforms (i.e. annex ZA of this EN);
- particular conditions applicable to the use of the product (e.g. provisions for use under certain conditions);
- name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or of his authorised representative.

The above mentioned declaration shall be presented in the official language or languages of the Member State in which the product is to be used.

ZA.3 CE marking

The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol to affix shall be in accordance with Directive 93/68/EC and shall be shown on the accompanying commercial documents (e.g. a delivery note). The following information shall accompany the CE marking symbol:

- name or identifying mark and registered address of the producer;
- the last two digits of the year in which the marking is affixed;
- reference to this European Standard (EN 12467);
- description of the product: generic name, material, and intended use;
- AT or NT with reference to 5.1.1;
- size (e.g. width or length and thickness), technical Class 1, 2, 3, 4 or 5 and category;
- reaction to fire class (where relevant) or class F;

The “No performance determined” (NPD) option may not be used where the characteristic is subject to a threshold level. Otherwise, the NPD option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements in the Member State of destination.

Figure ZA.1 gives an example of the information to be given on the commercial documents, for a sheet intended to be used internally or externally as a wall covering.

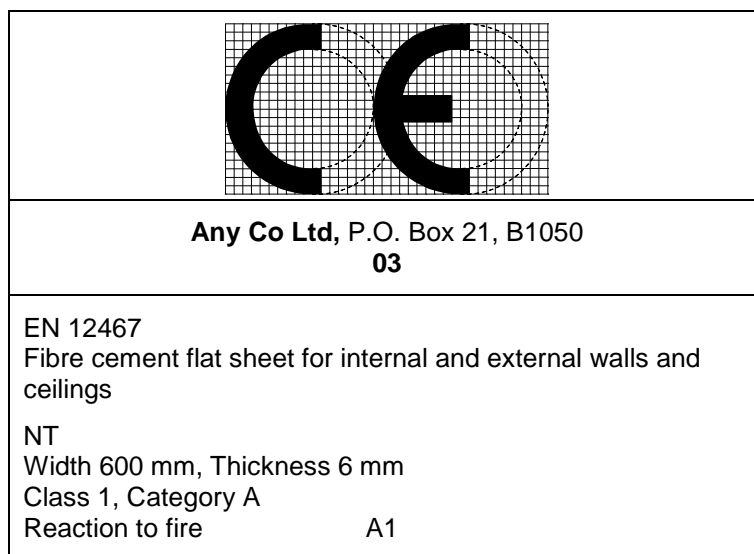


Figure ZA.1— Example CE marking information

In addition to any specific information relating to dangerous substances shown above, the component should also be accompanied, when and where required and in the appropriate form, by documentation listing any

other legislation on dangerous substances for which compliance is claimed, together with any information required by that legislation.

NOTE European legislation without national derogations need not be mentioned.

Annex ZB (informative)

Survey of legislation relating to EC Directive 76/769/EEC

NOTE CEN Member Bodies are requested to check their national regulatory provisions. In case these do not correspond with the information provided in this draft standard, the CEN Member Bodies are requested to provide the relevant clause. This will be regarded as an editorial modification and introduced by CMC before publication. This note will be removed after UAP and any new information from Member Bodies incorporated. If information is not available from all countries, the following will be added to annex ZB in the 2nd paragraph: "... with regard to this European Standard are known to exist in Austria, ..., Switzerland and the United Kingdom. Regulations may exist in other countries and are, in this case, also applicable."

This European Standard falls under EC Directive 89/106/EEC. Due to the implementation of EC Directive 76/769/EEC, as amended, some countries prohibit or restrict the production, bringing onto the market or use of construction products containing some or all types of asbestos fibres.

EC Directives and national regulations with regard to this European Standard exist in Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Luxembourg, Malta, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom.

NOTE The regulations listed below are assumed to be correct at the time of publication. Manufacturers should, however, ensure that they comply with current regulatory requirements.

The references of their national regulations are the following:

Clause 5.1.1 Composition

EUROPEAN UNION

Commission Directive of 3 December 1991 adapting to technical progress annex 1 to Council Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations (asbestos). This Directive adapts the Annex to Directive 76/769/EEC by banning the placing on the market of Crocidolite, Amosite, Anthophyllite asbestos, Actinolite asbestos and Tremolite asbestos and by banning the intentional marketing of products containing these fibres. Additionally, Chrysotile is banned in toys, spraying materials, products retailed in powder form, items for smoking, catalytic filters and heaters, paints and varnishes, filters for liquids, certain road surfacing materials, mortars, protective coatings, fillers, sealants, jointing, mastics, glues, decorative powder and finishes, gas distribution filters, low density insulating or soundproofing materials, underlays for plastic floor and wall coverings, roofing felt, filters for liquids and untreated finished textiles.

Council Directive of 20 December 1985 amending for the seventh time (asbestos) Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations. This Directive supplements the annex to Directive 76/769/EEC for the following asbestos fibres:

- Chrysotile, CAS No.12001-29-5
- Amosite, CAS No.12172-73-5
- Anthophyllite, CAS No.77536-68-6 6.3.1

The placing on the market and the use of products containing these fibres shall be prohibited for:

- materials or preparations intended to be applied by spraying. Member States may, however, allow on their territories bituminous compounds containing asbestos intended to be applied by spraying as vehicle under-sealing and for anti-corrosion protection;
- finished products which are retailed to the public in powder form;
- catalytic filters and insulation devices for incorporation in catalytic heaters using liquefied gas;
- paints and varnishes.

Council Directive of 19 September 1983 amending for the fifth time (asbestos) Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations.

Commission Directive 1999/77/EC of 26 July 1999 adapting to technical progress for the sixth time Annex I. Directive 83/478 amends and extends the scope of the parent Directive to include restrictions on the marketing and use of the asbestos fibre crocidolite, depending on the date when the product containing the fibre was manufactured. Certain products are excluded from the ban where no substitute is available. Additionally, the Directive bans marketing and use of all asbestos fibres unless labelled in accordance with the provisions of Annex II. Member States shall take all necessary measures to ensure that the dangerous substances and preparations listed in Annex I may only be placed on the market or used subject to the conditions specified therein.

Directive 1999/77/EC prohibits the use of Chrysotile. Member States shall bring into force the necessary provisions by 1st January 2005.

ÖSTERREICH

Verordnung des Bundesministers für Umwelt, Jugend und Familie und des Bundesministers für Arbeit und Soziales vom 10 April 1990 über Beschränkungen des Inverkehrsetzens und des Herstellens, des Verwendens sowie über die Kennzeichnung asbesthaltiger Stoffe, Zubereitungen und Fertigwaren (Asbestverordnung), BGBl Nr 324/1990.

AUSTRIA

Regulation of the Federal Minister of Environment, Youth and Family and the Federal Minister of Labor and Welfare dated April 10, 1990 regarding restrictions on placing on the market and production, application as well as concerning the marking of materials or substances containing asbestos, preparations and ready-made products. Federal Bill No 324/1990.

BELGIQUE

Arrêté royal limitant la mise sur le marché, la fabrication et l'emploi de certaines substances et préparations dangereuses (amiante).

Arrêté royal du 3 février 1998 (Moniteur belge du 21 février 1998).

BELGIË

Koninklijk besluit tot beperking van het op de markt brengen, de vervaardiging en het gebruik van bepaalde gevaarlijke stoffen en preparaten (asbest).

Koninklijk besluit van 3 februari (Belgisch Staatsblad van 21 februari 1998).

BELGIUM

Royal decree limiting the placing on the market, production and usage of certain dangerous substances and preparations (asbestos).

Royal decree of 3 February 1998 (Belgian law gazette of 21 February 1998).

CZECH REPUBLIC

In accordance with Decree No 76/1990 Coll. issued by the Ministry of Health and Social Affairs - of the Chief Hygienist of the Czech Socialist Republic which modifies and amends the Directive of the Ministry of Health and Social Affairs - of the Chief Hygienist of the Czech Socialist Republic No. 647/1984 Coll.- "Directive on hygienic principles for working with chemical carcinogenes" - the use of products containing asbestos is restricted (see § 11a, 11b of the Decree No, 76/1990 Coll.)

DENMARK

Bekendtgørelse om asbest (Nr. 660 af 24. september 1986)

Bekendtgørelser om ændring af bekendtgørelse om asbest

(Nr. 139 af 23. marts 1987)

(Nr. 984 af 11. december 1992)

Ifølge denne bekendtgørelse er anvendelse af asbestprodukter ikke tilladt i Danmark.

DENMARK

Order on the use of asbestos (Order No. 660 of 24 September 1986)

Orders to amend the order on asbestos

(Order No. 139 of 23 March 1987)

(Order No. 984 of 11 December 1992)

According to this order, the use of AT products is not allowed in Denmark.

FINLAND

Valtioneuvoston päätös asbestin ja asbestipitoisen tuotteen valmistuksen, maahantuonnin, myymisen ja käyttöön ottamisen kieltämisestä.

852/92 27 elokuuta 1992

FINLAND

Decision of the Council of State concerning prohibition of the manufacture, importation, sales and use of asbestos and asbestos-bearing products.

852/92 27th of August, 1992

FRANCE

- Décret No 96-1133 du 24 décembre 1996 relatif à l'interdiction de l'amiante, pris en application du code du travail et du code de la consommation.

- de l'arrêté du 24 décembre 1996 relatif au formulaire de déclaration en vue d'exceptions à l'interdiction de l'amiante.

Conformément à ce décret, la fabrication, l'importation, la mise sur le marché national, l'exportation, la détention en vue de la vente, l'offre, la vente et la cession à quelque titre que ce soit de toutes les variétés de fibres d'amiante et de tout produit en contenant sont interdites.

FRANCE

- Order No 96-1133 of December 24, 1996 relative to the prohibition of asbestos, in conformity with the Labour Code and the Consumer Code.
- Order of December 24, 1996 relative to the declaration form in view of exceptions to the prohibition of asbestos.

In accordance with the order, it is forbidden to manufacture, import, put on the market, export, sell all types of asbestos fibers or products containing those fibers.

GERMANY

Verordnung über Verbote und Beschränkungen des Inverkehrbringens gefährlicher Stoffe, Zubereitungen und Erzeugnisse nach dem Chemikaliengesetz (Chemikalien-Verbotsordnung) vom 19. Juli 1996 der Bekanntmachung im BGB1. Teil 1, Nr. 39 vom 31.07.1996, S. 1151.

Verordnung zum Schutz vor gefährlichen Stoffen (Gefahrstoffverordnung) in der Fassung vom 15. November 1999 der Bekanntmachung in BGB1. Teil 1 Nr. 52 vom 29.11.1999, S. 2223 und der Änderung im BGB1. Teil 1 in Nr. 23 vom 25.05.2000, S. 739.

GERMANY

Regulation concerning bans and restrictions of placing on the market of dangerous substances, admixtures and products according to the chemical law (Chemikalien-Verbotsordnung) from July 19th, 1996, Federal Bill 1996 Part 1, p. 1151.

Regulation concerning protection from dangerous substances (Gefahrstoffverordnung) from November 15th, 1999, Federal Bill 2000, Part 1 p. 739.

ICELAND

Regulation 379/1996 on asbestos (and regulation 74/1983) Import, production, use or treatment of asbestos or goods containing asbestos is prohibited.

IRELAND

Regulation of the Minister for Enterprise, Trade and Employment dated April 5, 2000 regarding marketing and use of dangerous substances and preparations (asbestos). S.I. No. 107 of 2000.

ITALIA

"Norme relative alla cessazione dell'impiego di amianto"

Legge N. 257 del 27-03-1992 secondo cui, a partire dal 28-04-1994, sono consentiti dalla legislazione italiana solo i tipi NT.

ITALY

Standards concerning the suspension of the use of asbestos.

Law N. 257 dtd 1992-03-27 according to which, starting from 1994-04-28, Type NT only are allowed.

LUXEMBOURG

Support the principle of a total ban on asbestos fibres but still use and import chrysotile (white asbestos).

MALTA

In accordance with the Legal Notice 129 "prohibition of importation of asbestos fibres regulations" the use of asbestos is not allowed in Malta.

NEDERLAND

Asbestbesluit Arbeidsomstandighedenwet (Ministerie van SZW) (Staatsblad 1993, 136 inclusief wijziging in Staatsblad 1994, 562)

Warenwetbesluit Asbest (Ministerie van VWS) (Staatsblad 1994, 674)

Asbestbesluit Milieubeheer (Ministerie van VROM) (Staatsblad 1993, 42, inclusief wijziging in Stb. 1993, 583)

Besluit Aanwijzing Gevaarlijke Afvalstoffen (Ministerie VROM) (Staatsblad 1993, 617)

THE NETHERLANDS

Asbestbesluit Arbeidsomstandighedenwet (Ministerie van SZW) (Staatsblad 1993, 136 inclusief wijziging in Staatsblad 1994, 562)

This decree gives rules for the work with asbestos in a professional situation. As from July 1st working with asbestos is prohibited. This concerns employers, employees and independent workers.

This decree lists which products containing asbestos are prohibited (among them are fibre-cement products). It also gives rules for the labelling of asbestos products.

Warenwetbesluit Asbest (Ministerie van VWS) (Staatsblad 1994, 674)

Asbestbesluit Milieubeheer (Ministerie van VROM) (Staatsblad 1993, 42, inclusief wijziging in Stb. 1993, 583)

In this decree requirements are given on the amount of asbestos emitted into the air by factories.

Besluit Aanwijzing Gevaarlijke Afvalstoffen (Ministerie VROM) (Staatsblad 1993, 617)

This decree gives rules on waste with asbestos.

NORGE

Forskrift om asbest.

Fastsatt av Kommunaldepartementet 16 august 1991, endret 30 juni 1995.

Ifølge denne forskriften er det forbudt å importere, fremstille, omsette eller bruke i arbeidslivet plater som inneholder asbest i Norge.

NORWAY

The Asbestos regulations.

Issued by the Ministry of Local Government 16 August 1991, amended 30 June 1995.

Pursuant to these regulations, it is forbidden to import, manufacture, sell, or use for professional purposes, sheets containing asbestos in Norway.

SPAIN

Ministerial Order 23636 of 7-12-2001 modifying the annex I of royal Decree 1406/1988 of November the 10th, relative to the limitation on commercialisation and use of certain dangerous substances and products.

SWEDEN

Arbetskyddsstyrelsens kungörelse med föreskrifter om asbest

(AFS 1996:13, Beslutad den 5 December 1996).

SWEDEN

Ordinance of the Swedish National board of Occupation Safety and Health containing Provisions on Asbestos, together with General recommendations on the implementation of this Provisions.

(AFS 1996:13, Adopted 5th December 1996).

According to this Ordinance it is not allowed to use AT products in Sweden.

SCHWEIZ

Verordnung über umweltgefährdende Stoffe (Stoffverordnung, StoV) 814.013 vom 09. Juni 1986 (Stand 12. Januar 1999)

Die Verwendung von asbesthaltigen grossformatigen Platten und Wellplatten dürfen gemäss StoV nicht mehr abgegeben oder eingeführt werden.

SWITZERLAND

Verordnung über umweltgefährdende Stoffe (Stoffverordnung, StoV) 814.013 vom 09. Juni 1986 (Stand 12. Januar 1999)

In accordance with above mentioned regulation, the use of asbestos is not allowed in Switzerland.

THE UNITED KINGDOM

The Statutory Instrument 1999 No 2373 - The Asbestos (Prohibitions) (Amendment) Regulations 1999 - Prohibits the sale or use of asbestos containing products in the UK.

Bibliography

- [1] EN ISO 9001; *Quality management systems – Requirements (ISO 9001:2000)*.